FORM PTO-1390 (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: MEIC:115

U.S. APPLICATION NO (If known, see 37 CFR 1.5): 10/009448

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/03740	9 June 2000	15 June 1999

TITLE OF INVENTION: POWER CONTROLLER AND COMPRESSOR OF REFRIGERATING SYSTEM

APPLICANT(S) FOR DO/EO/US: Koji HAMAOKA, Osaka-shi, Japan; Keiji OGAWA, Yamatokoriyama-shi, Japan; Tomonori NAKANO, Higashiosaka-shi, Japan.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [x] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [x] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [x] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [x] Other items or information:
    Amendment Under Article 34 with Translation;
    Forms PCT/IB/301; 304; 308; 332; IPEA/408; 409;
    The Executed Declaration and Assignment with fees will follow in due course.

PLEASE ACCEPT THIS AS AUTHORIZATION TO DEBIT OR CREDIT FEES TO DEP. ACCT. 16-0331 PARKHURST & WENDEL

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 10/009448	INTERNATIONAL APPLICATION NO. PCT/JP00/03740	ATTORNEY'S DOCKET NUMBER METC:115

JC07 Rec'd PCT/PTO 10 DEC 2001

17. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

	CALCULATIONS	PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,040.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	5 - 20 =	0	X $18.00	$	
Independent claims	1 - 3 =	0	X $84.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $280.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 890.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 890.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 890.00	
				Amount to be: refunded	$
				charged	$

a. [X] A check in the amount of $ 890.00 to cover the above fees is enclosed. CK# 14787

b. [ ] Please charge my Deposit Account No. ________ in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 160331. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
Roger W. Parkhurst
PARKHURST & WENDEL, L.L.P.
1421 Prince St., Ste. 210
Alexandria, VA 22314-2805
Tel: (703) 739-0220

[signature]
SIGNATURE

Roger W. Parkhurst
NAME

25,177
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Koji HAMAOKA et al.

Serial No.: New Application (PCT/JP00/03740)

Filed: December 10, 2001

For: POWER CONTROLLER AND COMPRESSOR OF REFRIGERATING SYSTEM

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application, please enter the following specification changes as noted below:

IN THE CLAIMS:

Please cancel claims 1-7.

Please add new claims 8-12 as follows:

8. (New) A compressor comprising:

an electric element;

a first case for accommodating said electric element;

a conductive pin coupled with said electric element;

a bracket provided to said first case around said conductive pin;

a control board for controlling said electric element;

a second case for accommodating said control board;

a fixing section provided to said second case, for mounting said second case to said bracket; and

a cluster socket extending from said control board via a cable, for being coupled to said conductive pin.

9. (New) The compressor of claim 8, wherein said control board including:

a first board including an inverter mounted thereto;

a second board including a control circuit mounted thereto, said second board being placed in parallel with said first board; and

a heat sink mounted to said first board,

wherein said second case has a slit through which said heat sink extends outside said second case.

10. (New) The compressor of claim 8, wherein said control board including:

a first board including an inverter mounted thereto;

a second board including a control circuit mounted thereto, said second board being placed in parallel with said first board; and

a capacitor disposed on said second board at a side opposite to said first board,

wherein said first and said second boards are fixed by fluid resin to said second case.

11. (New) The compressor of claim 8, further comprising:

temperature detecting means disposed in said bracket, for detecting a temperature of said first case; and

a resilient supporting member for having said temperature detecting means solidly contact with said first case.

12. (New) The compressor of claim 8, wherein said second board is larger than said first board, and said first board is placed over a corner of said second board.

REMARKS

Claims 8-12 remain herein.

This Preliminary Amendment is submitted to conform to the Article 34 Amendment submitted in the corresponding International Application.

Examination of this application on its merits is respectfully requested.

Respectfully submitted,

PARKHURST & WENDEL, L.L.P.

December 10, 2001
Date

Roger W. Parkhurst
Registration No. 25,177

RWP/ame

Attorney Docket No. MEIC:115

PARKHURST & WENDEL, L.L.P.
1421 Prince Street, Suite 210
Alexandria, Virginia 22314-2805
Telephone: (703) 739-0220

DESCRIPTION

Power Controller and Compressor of Refrigerating System

Technical Field

The present invention relates to a power controller, such as an inverter, for driving a compressor motor of a refrigerating system at variable speeds.

Background Art

As power electronics has progressed recently, power controllers are employed in various fields. For instance, an inverter is used in a refrigerator and air cleaner for saving energy, and contributes greatly to energy saving of the apparatuses. The power controller has encountered a problem of how to dissipate heat from power elements, and various improvements have been carried out for the problem.

The Japanese Patent Laid-Open Publication No.09-283883 discloses a conventional power controller. Fig. 10 is a sectional view of the conventional power controller. Power converter 101 generates greater heat than the other components in the power controller. Large size radiator 102 is mounted to power converter 101 for dissipating the generated heat. First circuit board 103 is electrically connected to power converter 101, and mounted with smoothing capacitor 105 and voltage regulator 106 generating control-power-supply. First spacer 104 rigidly bonds radiator 102 to first circuit board 103. On second circuit board 107, controlling components such as a microprocessor (not shown) is mainly mounted. Second spacer 108 rigidly bonds first circuit board 103 to second circuit board 107. Cover 109 is mounted for covering these circuit components.

The conventional power controller discussed above has a problem that the controller itself has a large size. Particularly in a refrigerating system, e.g., a refrigerator, an available capacity of the system decreases as the power controller becomes large. The larger size controller requires a greater number of assembling steps to be assembled, and this increases a cost of the system.

Disclosure of the Invention

In a power controller of the present invention, a controlling board is directly mounted to a compressor and thus, integrated with the compressor. This structure allows the controlling board to occupy a substantially less space.

A first board and second board bonded to each other with resin are directly mounted to a compressor. This structure allows the power controller to be reinforced and not to be affected by vibrations.

When a case of the power controller is mounted to the compressor, a temperature detector, which protects the compressor, is adheres to the compressor solidly and fixed to resilient supporting member. This structure reduces a number of steps for mounting a temperature protector to the compressor, and reduces a number of assembling steps to assemble the controller.

The second board being larger than the first board is prepared, and high-profile components to be mounted to the second board are placed around the first board. This arrangement can further slim down the power controller, and reduces substantially the capacity that the controller occupies.

An electrolytic capacitor is disposed on the second board, then a resin is flowed between the first and second boards until burying one third of the

capacitor in height. The resin rigidly bonds the first and second boards. This structure not only further thins the power controller and reduces substantially the capacity that the controller occupies, but also reinforces the power controller, thus allowing the board to avoid being subject to vibrations.

The board, upon being directly mounted to the compressor, can downsize the controller. A case containing the controlling board, upon being mounted to a bracket of the compressor, can prevent a power-supplying pin from a weight stress and thus avoid the pin to be damaged.

Brief Description of the Drawings

Fig. 1 is a sectional view of a power controller of a refrigerating system in accordance with exemplary embodiment 1.

Fig. 2 is a circuit diagram of a power controller of a refrigerating system in accordance with the present invention.

Fig. 3 illustrates connections of the power controller in accordance with embodiment 1.

Fig. 4 is a perspective view of the power controller in accordance with embodiment 1.

Fig. 5 is a plan view of a first board in accordance with embodiment 1.

Fig. 6 is an enlarged view of fixing section 11 in accordance with embodiment 1.

Fig. 7 is a sectional view of a power controller of a refrigerating system in accordance with exemplary embodiment 2.

Fig. 8 is a perspective view of a compressor in accordance with exemplary embodiment 3.

Fig. 9 is a lateral view illustrating the compressor shown in Fig. 8 having a case mounted thereon.

Fig. 10 is a sectional view of a conventional power controller.

Detailed Description of the Preferred Embodiments

(Exemplary Embodiment 1)

Fig. 1 is a sectional view of a power controller of a refrigerating system in accordance with exemplary embodiment 1, and is a horizontal sectional view with respect to a mounted compressor.

First board 1 includes lead-frame 1A and highly heat-conductive resin sheet 1B unitarily molded with each other to which heat and pressure is applied. Lead-frame 1A is made of copper plate of 0.5mm thickness cut into patterns. Resin sheet 1B is made of thermosetting resin, e.g., epoxy, and highly heat-conductive material, e.g., aluminum oxide. First board 1 thus exhibits efficient heat dissipation. When heat and pressure are applied to these elements, heat sink 2 can be added to the elements for being unitarily molded.

Power element 3, which functions as a major component in the power controller, is a heating component such as a MOS FET or an IGBT. A rectifier diode is also one of heating components. These heating components 3 are mounted on first board 1. A controlling circuit including microprocessor 5, connector 6 and the like mounted to second board 4, which is made of ordinary paper phenol or glass epoxy. First board 1 is placed in parallel with second board 4, and lead frame 1A couples first board 1 with second board 4. Lead frame 1A is bent after the unitary molding and the components mounting.

Smoothing capacitor 7 is connected to the rectifier diode, and lowers a DC ripple voltage undergone the rectifying. Smoothing capacitor 7 is coupled to second board 4 via lead-wires, and placed opposite to heat sink 2 with respect to second board 4. This placement allows capacitor 7 to be hardly

subject to the heat generated by heating components 3. Capacitor 7 is also hardly subject to vibrations as being rigidly mounted to second board 4 with resin 8.

Case 9 accommodates first board 1, second board 4, and smoothing capacitor 7 compactly. Case 9 has slit 9A through which heat sink 2 mounted to first board 1 extends outside of case 9, and also has slit 9B through which connector 6 mounted to second board 4 extends outside of case 9.

Heat sink 2, since being exposed outside case 9 from slit 9A, has an improved heat dissipation, which restrains the temperature rise of heating components 3. Connector 6, since being exposed outside case 9 from slit 9B, allows an outer circuit to be connected thereto easily.

Filler resin 10, e.g., silicone resin, has fluidity at an initial filling stage, and is used for burying first board 1 and second board 4. After that, resin 10 is hardened by heating or so. First board 1 and second board 4 are thus fixed keeping in parallel, so that connection strength against vibrations between the boards increases.

Fixing section 11, which fixes the power controller of the refrigerating system to a compressor, is provided to case 9 on the compressor side. Protrusions 11A are provided inside fixing section 11 for mating with a mounting section of the compressor. The compressor is thus rigidly mounted to fixing section 11.

Fig. 2 is a circuit diagram of the power controller of the refrigerating system in accordance with the present invention. The power controller, namely, an inverter drives a compressor motor of the refrigerating system at variable speeds. Regarding commercial power source 20, power of 100V, 50Hz or 60Hz is available in most of Japanese private homes. Converter 21 converts AC of commercial power source 20 into DC. Converter 21 includes

bridge-connected two rectifier diodes 21A and 21B and provides commercial power source 20 with double-voltage rectifying. Electrolytic capacitors 21C and 21D are connected between positive voltage output from rectifier diode 21A, negative voltage output from diode 21B and another power line respectively, and smoothes the voltage undergone double-voltage rectifying to produce DC voltage (approx. 280V) double the input voltage.

Inverter 22 receives the DC voltage output from converter 21 and converts the DC voltage to a three-phase AC power having an arbitrary frequency and an arbitrary voltage. In inverter 22, IGBT 22A – IGBT 22F are connected respectively in three-phase bridge, and respectively connected to high-speed diodes (not shown) in parallel. In these diodes, circulating currents generated when IGBT 22A – IGBT 22F are turned off flow.

Motor 23 is driven by three-phase AC output from inverter 22. A highly efficient brushless DC motor is used as motor 23. The brushless DC motor has magnets in the rotor, thus efficient operation can be expected. Motor 23 rotates at a speed responsive to an output frequency of inverter 22.

Position-detecting circuit 24 detects a relative rotational position of the rotor of motor 23 based on back electromotive force of the motor.

Using a microprocessor and the like, inverter control circuit 25 produces a waveform for driving IGBTs 22A - 22F of inverter 22 based on the resultant position detected by position detecting circuit 24. Control circuit 25 detects an abnormality of inverter 22 and takes protective action.

Power supply circuit 26 receives DC output from converter 21, and outputs the power activating position detecting circuit 24 and inverter control circuit 25.

Power controller 27 thus includes converter 21, inverter 22, position detecting circuit 24, inverter control circuit 25 and power supply circuit 26.

Refrigerating system control circuit 28 is disposed outside power controller 27. This control circuit 28 controls the entire refrigerating system, determines a rotation speed of the compressor, and gives an instruction about the rotation speed. to inverter control circuit 25. This instruction is delivered via, e.g., serial communication.

Quick refrigerating switch 29 is disposed on a side at a user of the refrigerating system. When the user presses the switch to refrigerate something quickly, refrigerating system control circuit 28 raises the rotation speed. of the compressor, and instructs inverter control circuit 25 to realize this rotation speed. Temperature input circuit 30 detects a temperature in a compartment of the refrigerating system (e.g., in a case of a refrigerator, the temperature of the refrigerator compartment.) Based on an output of temperature input circuit 30, refrigerating system control circuit 28 determines the rotation speed. of the compressor, and sends an instruction signal to inverter control circuit 25. Load-driving circuit 31 driven by refrigerating-system-control circuit 28 drives a fan motor, a defrosting heater (not shown) and the like.

Mounting the components in the power controller is detailed hereinafter. The power controller of the refrigerating system shown in Fig. 1 incorporates power controller 27 shown in Fig. 2 into case 9. Refrigerating system control circuit 28 is disposed at a place different from controller 27, such as behind the refrigerating system.

In Fig. 1, heating components 3 mounted on first board 1 are rectifier diodes 21A, 21B, and IGBT 22A – 22F. Because the power for driving motor 23 runs through these components, great amount of loss and heat are generated. Each of these heating components is mounted on first board 1. On second board 4, inverter control circuit 25 including such as a

microprocessor, position detecting circuit 24, power supply circuit 26 are mounted.

Fig. 3 illustrates connections of the power controller of the refrigerating system in accordance with embodiment 1. Compressor 40 compresses coolant gas (e.g., HFC-134a) by spinning the motor therein. The compressed coolant gas circulates through the refrigerating system (not shown), including a condenser, a de-compressor and an evaporator, for cooling. Rubber isolator 41 prevents the compressor 40 from vibrations conveyed to the body of the refrigerating system. Mounting bracket 42 connects compressor 40 to power controller 43 and fixes them at fixing section 11. Bracket 42 has holes for engaging with protrusions 11A of fixing section 11, and is fixed to controller 43. Refrigerating system control board 44 is mounted with refrigerating system control circuit 28 shown in Fig. 2 and the like. An instruction about the rotation speed and so on from refrigerating system control board 44 is supplied through connector 6 of the power controller via communication cable 45.

Fig. 4 is a perspective view of the power controller in accordance with embodiment 1. Fixing section 11 is fixed to case 9. Fixing section 11 has protrusions (not shown) in three directions except the downward direction for engaging with mounting bracket 42 of the compressor. Heat sink 2 has fins exposed from slit 9A provided in case 9. This structure prevents filler resin from leaking out of slit 9A, and allows the fins to direct vertically to improve the heat dissipation in air-cooling operation. Connector 6 has an edge exposed out of slit 9B for easy connection to an outer circuit. The structure discussed above allows the power controller to be downsized and integrated with the compressor. This structure thus reduces substantially the capacity occupied by the power controller in the refrigerating system. Second board 4 is placed in parallel with first board 1 having heat sink 2, and coupled to first

board 1 via a lead frame. Smoothing capacitor 7 is placed on second board 4 and at a side opposite to heat sink 2. This placement prevents capacitor 7 from being affected by the heat dissipated from the heating components.

Fig. 5 is a plan view of second board 4 in accordance with embodiment 1. First board 1 is mounted above area A shown as dotted lines. In the area A, low-profile components such as microprocessor 50, IC 51, chip resistor 52, chip capacitor 53 are disposed. In the other areas, high-profile components such as connector 6, electrolytic capacitor 54, discrete components 55 and coil 56 are disposed. The structure discussed above can minimize the length of lead-frame 1A of first board 1, thereby increasing the mechanical strength and downsizing the power controller.

Fig. 6 is an enlarged view of fixing section 11 in accordance with embodiment 1. Cluster socket 60 is connected to cluster pins, which couple the compressor motor electrically with the outside. Temperature detector 61 is a bi-metal having a mechanical contact, or a thermistor. Detector 61 detects a surface temperature of the compressor, and inputs an output signal to the power controller to the compressor from an abnormal temperature rise. Resilient supporting member 62 has a first end fixed to fixing section 11, and has a second end fixed to temperature detector 61. When fixing section 11 is mounted to the compressor, resilient supporting member 62 is pressed, and urges detector 61 against the surface of the compressor, so that detector 61 solidly adheres to the surface of the compressor. Temperature detector 61 can thus positively detect a protective status. A number of steps for mounting the temperature detector can be reduced, and as a result, a number of assembling steps is reduced.

Heating components 3 including semiconductor elements housed in a package are described in embodiment 1, however, semi-conductor chips can be

connected to the first board by wire-bonding as a chip.

First board 1, being described as a board made of a lead-frame and resin, can be a highly heat dissipating board such as a metal base board.

(Exemplary Embodiment 2)

Fig. 7 is a sectional view of a power controller of a refrigerating system in accordance with exemplary embodiment 2. This is a vertical sectional view with respect to a mounted compressor. First board 1, heat sink 2, second board 4, connector 6, case 9 and fixing section 11 are the same as those shown in Fig. 1, and the detailed descriptions thereof are thus omitted here. Smoothing capacitor 7 is connected to second board 4, and placed on the same side of the heat sink. After the case is placed in the right position, resin 70 in high fluid condition is flowed into the case to bury entire first board 1 and one third of the capacitor. Resin 70 is then hardened by heating or the like. This structure allows the controller to be slimmer than that demonstrated in embodiment 1. Embodiment 2 can thus contribute to downsizing the controller. One third of the capacitor in height from the base is buried in resin 70, thereby increasing the mechanical strength.

(Exemplary Embodiment 3)

Fig. 8 is a perspective view of a compressor in accordance with exemplary embodiment 3. Fig. 9 is a lateral view illustrating the compressor shown in Fig. 8 housed by case 9. The elements similar to those in the previous embodiments are denoted by the same reference numbers, and the detailed descriptions thereof are thus omitted here. Compressor 40 has a compressive element and an electric element therein (both are not shown.) Container 40A has three conductive pins 40B for supplying electricity to the

electric element. Fixing section 11 of case 9 is fixed to bracket 80 provided around pins 40B. Fixed section 11 can be fixed to bracket 80 by engaging a claw therewith, or by screwing down. Before fixing section 11 is fixed, cluster socket 60 extending from control board 81 via cable 82 is connected to pins 40B, then the fixing section is mounted. Control board 81 includes first board 1 and second board 4, and can be mounted directly to compressor 40, thereby downsizing the controller. Further, fixing section 11 of case 9, since being directly mounted to bracket 81, prevents pins 40 from a weight stress, and thus, are free from damages.

Industrial Applicability

The present invention, as discussed above, relates to a power controller such as an inverter, which drives a compressor motor of a refrigerating system at variable speeds, and provides an inexpensive as well as a compact-size power controller.

In the power controller of the present invention, the controller, since being expected to have optimum heat dissipation, can be downsized and integrated into a compressor, and thus, can substantially reduce the capacity that the power controller occupies in the refrigerating system.

Fluid resin 10 flows and surrounds large-size smoothing capacitor 7 mounted on the board, and then, is hardened. Further, fixing section 11 is provided for fixing case 9 to the compressor. These arrangements strengthen the structure allows the power controller not to be affected by vibrations. Capacitor 7, since being placed away from first board 1 generating an amount of heat, is hardly affected by heat.

Resilient supporting member 62 is provided for urging temperature-detector 61 to the compressor when the controller is mounted to the

compressor. The temperature detector for protecting the compressor solidly adheres to the compressor to positively detect the protective condition. This structure saves a number of steps for mounting a temperature-protection to the compressor, and thus reducing a number of assembling steps.

Second board 4 is larger than first board 1, and first board 1 is placed on a corner of second board 4. This allows high-profile components to be placed around the first board. This placement can shorten a frame of the first board, increase mechanical strength, and downsize the controller.

Second board 4 is placed in parallel with first board 1, and capacitor 7 is mounted on second board 4 in the same direction of first board 1. Then, resin is flowed into case 9, which accommodates first board 1, second board 4 and capacitor 7, to bury one third or less than one third of the capacitor in height, then the resin is hardened. This structure slims down and downsizes the power controller.

A control board is directly mounted to the compressor, so that the refrigerating system can be downsized.

Further, the case accommodating the control board is mounted to a bracket of the compressor, thereby relieving power-supplying pins of weight stress. The pins are thus free from damages.

CLAIMS

1. (Deleted)

2. (Deleted)

3. (Deleted)

4. (Deleted)

5. (Deleted)

6. (Deleted)

7. (Deleted)

8. (Added) A compressor comprising:

an electric element;

a first case for accommodating said electric element;

a conductive pin coupled with said electric element;

a bracket provided to said first case around said conductive pin;

a control board for controlling said electric element;

a second case for accommodating said control board;

a fixing section provided to said second case, for mounting said second case to said bracket; and

a cluster socket extending from said control board via a cable, for being coupled to said conductive pin.

9. (Added) The compressor of claim 8, wherein said control board including:

a first board including an inverter mounted thereto;

a second board including a control circuit mounted thereto, said second board being placed in parallel with said first board; and

a heat sink mounted to said first board,

wherein said second case has a slit through which said heat sink extends outside said second case.

10. (Added) The compressor of claim 8, wherein said control board including:

a first board including an inverter mounted thereto;

a second board including a control circuit mounted thereto, said second board being placed in parallel with said first board; and

a capacitor disposed on said second board at a side opposite to said first board,

wherein said first and said second boards are fixed by fluid resin to said second case.

11. (Added) The compressor of claim 8, further comprising:

temperature detecting means disposed in said bracket, for detecting a temperature of said first case; and

a resilient supporting member for having said temperature detecting means solidly contact with said first case.

12. (Added) The compressor of claim 8, wherein said second board is

larger than said first board, and said first board is placed over a corner of said second board.

ABSTRACT

The present invention solves a problem that a power controller be large in a refrigerating system, and provides a compact-size as well as an inexpensive power controller. Highly heat-dissipating first board 1 including an inverter circuit mounted thereon and second board including a control circuit mounted thereon are placed in parallel with each other and accommodated by case 9. Case 9 has slits through which heat sink 2 and connector 6 can extend outside case 9, and further has fixing section 11 for fixing case 9 to a compressor. This structure allows the power controller to dissipate heat in an optimum manner and to be downsized, and also allows the compressor to integrate the controller thereinto. A capacity that the controller occupies in the refrigerating system can be substantially reduced.

Fig. 1

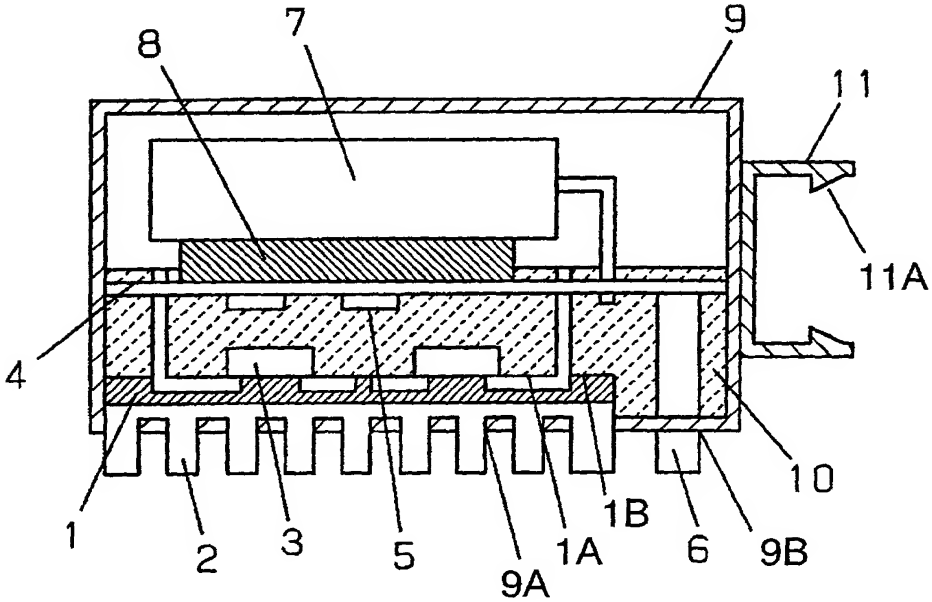


Fig. 2

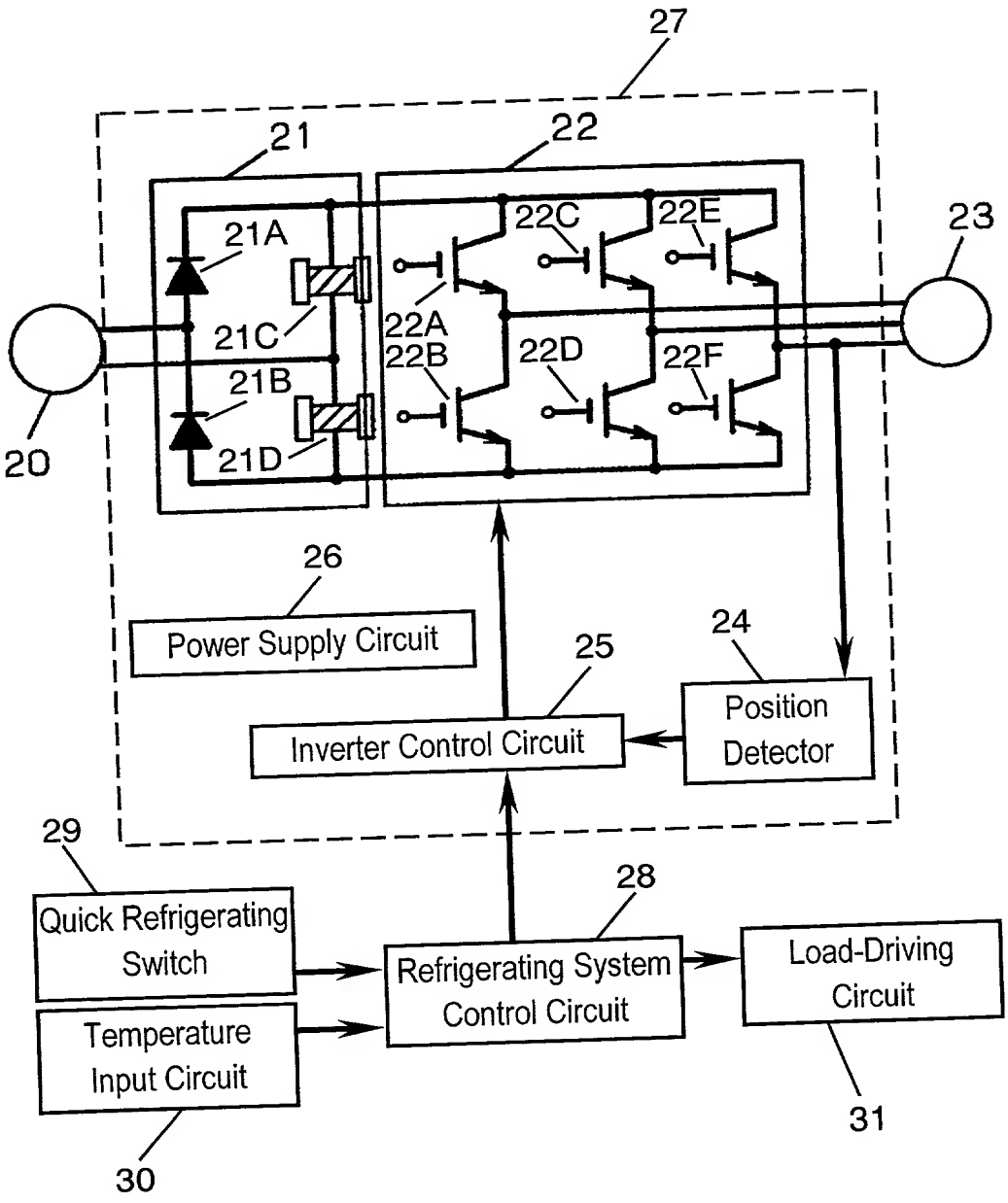

27
21
22
23
21A
22C
22E
21C
22A
22B
22D
22F
21B
21D
20
26
Power Supply Circuit
24
25
Position Detector
Inverter Control Circuit
29
28
Quick Refrigerating Switch
Refrigerating System Control Circuit
Load-Driving Circuit
Temperature Input Circuit
31
30

Fig. 3

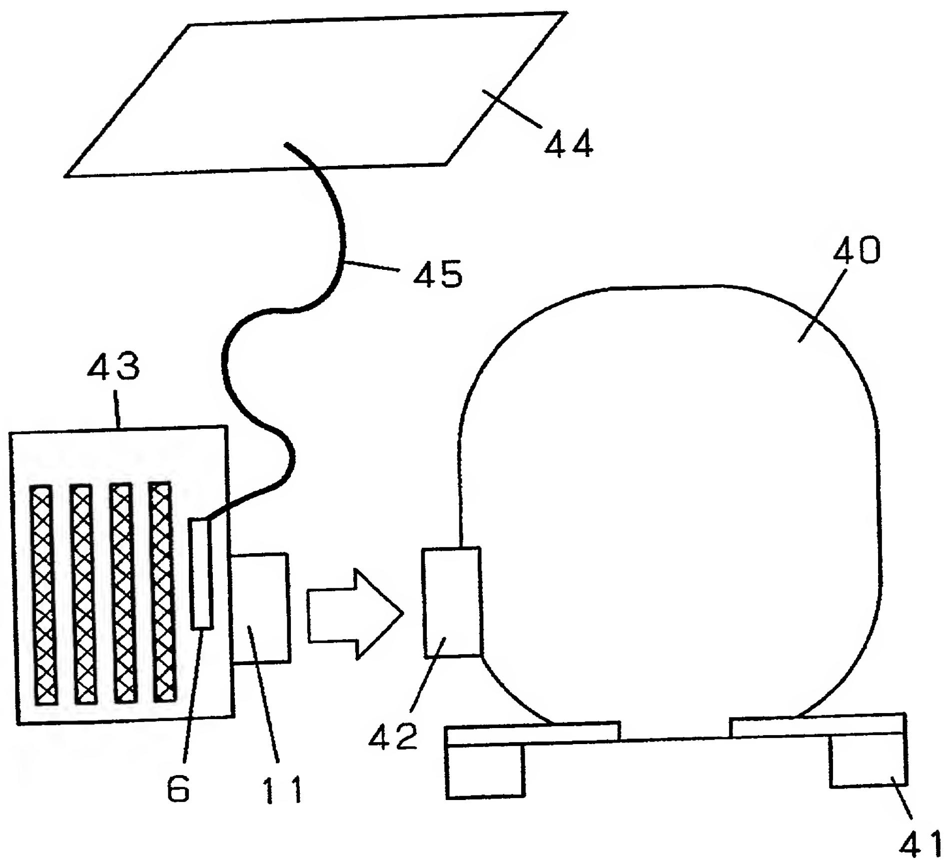


Fig. 4

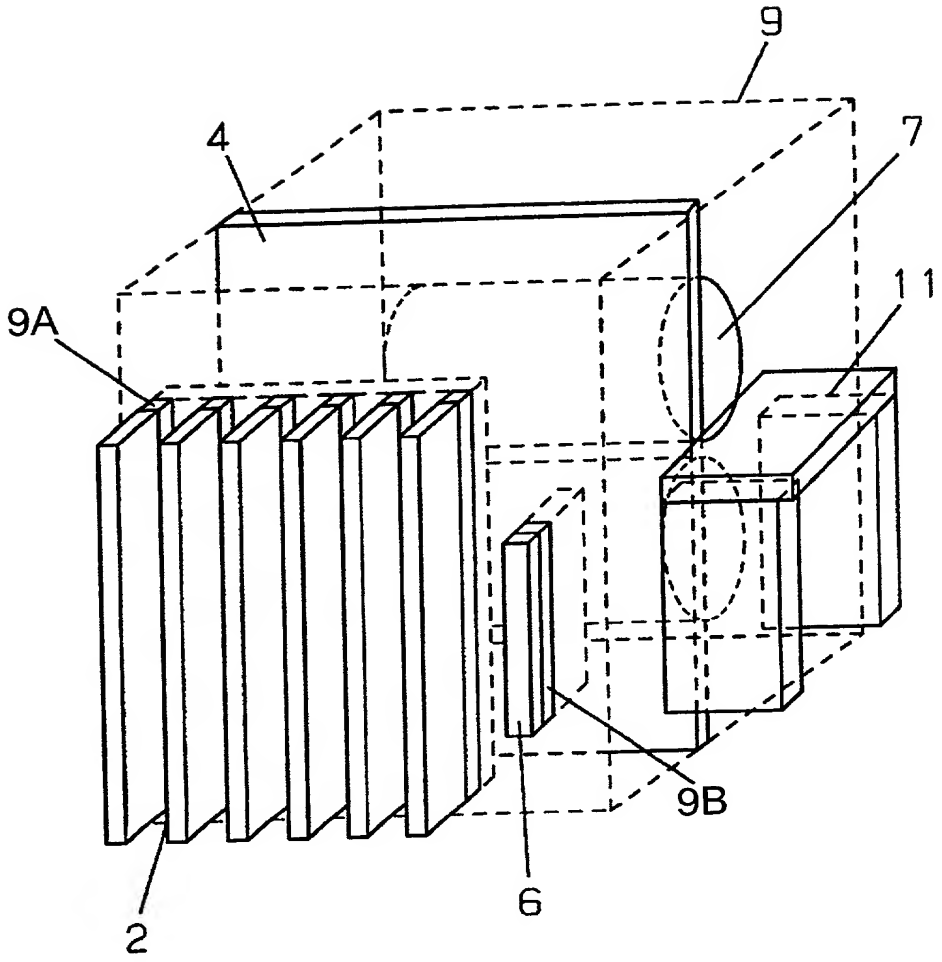


Fig. 5

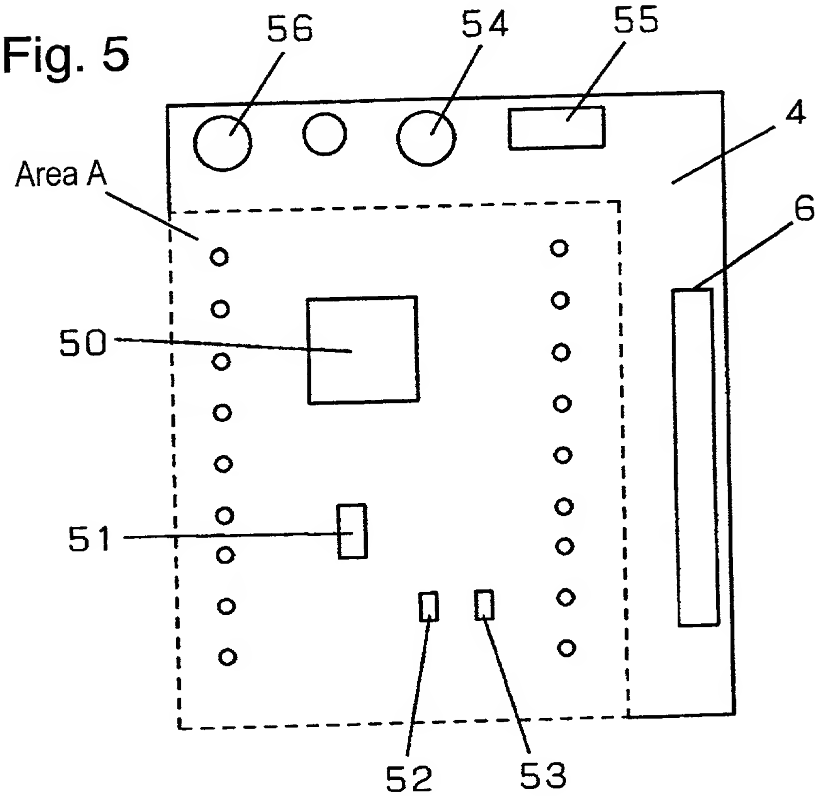


Fig. 6

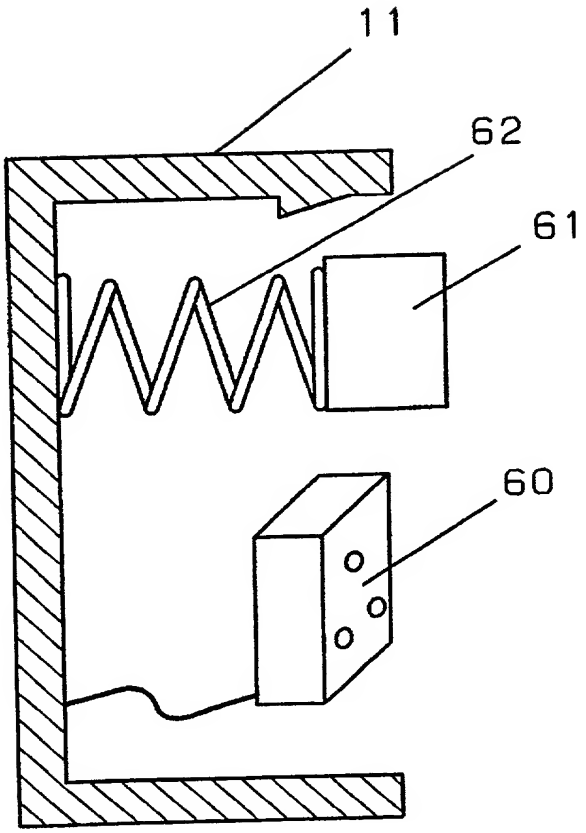


Fig. 7

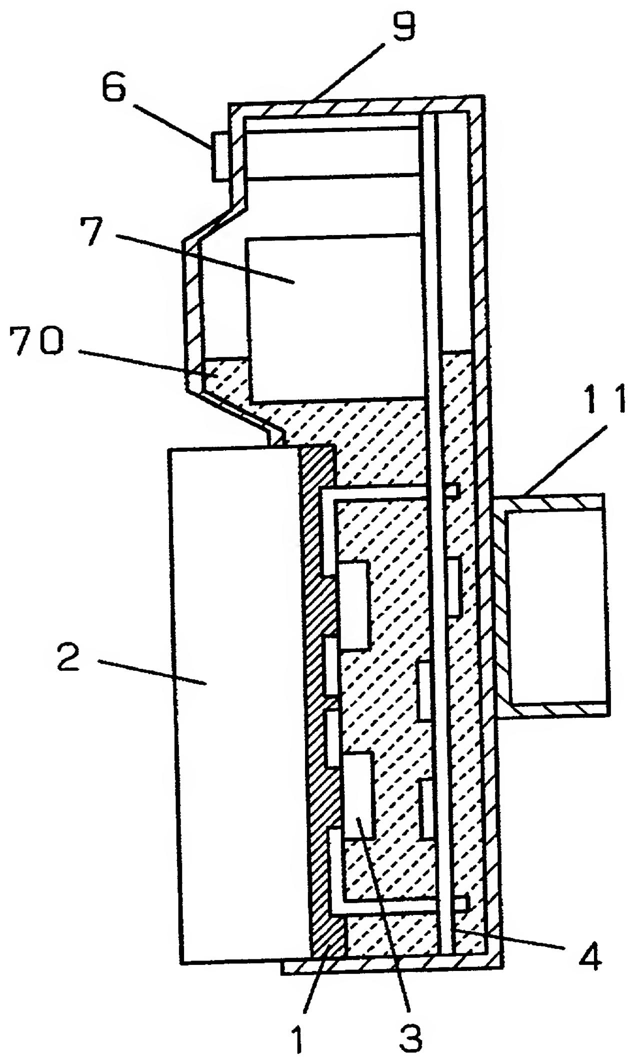


Fig. 8

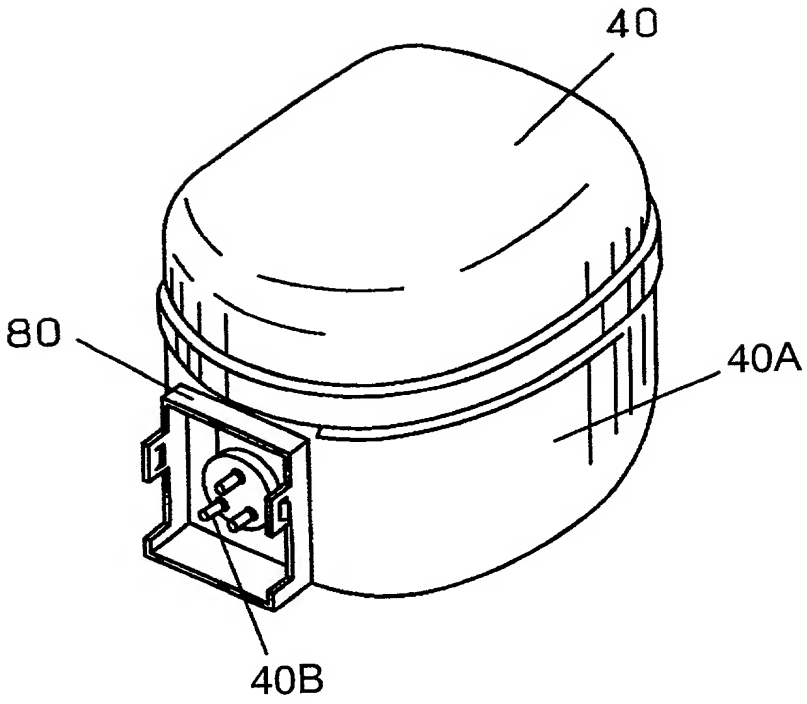


Fig. 9

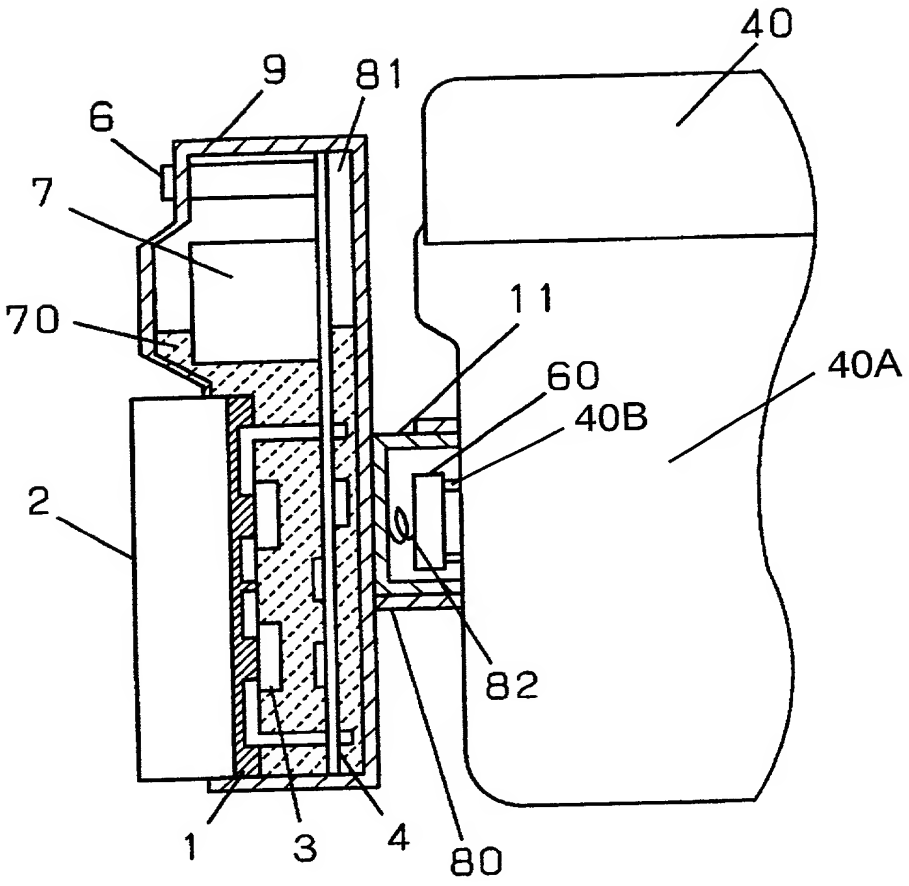
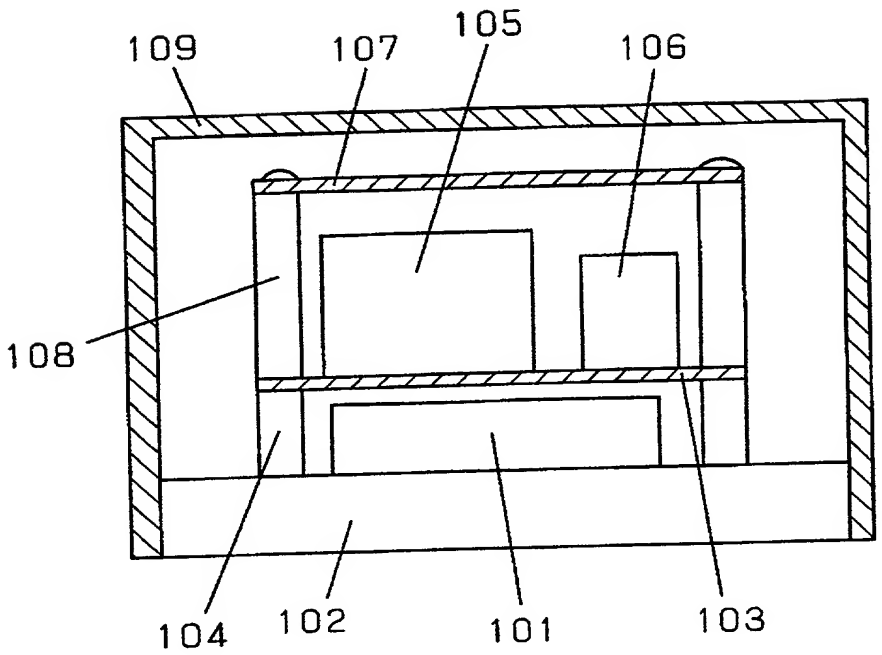


Fig. 10



Reference Numerals

1 First Board
1A Lead Frame
1B Resin Sheet
2 Heat Sink
3 Power Element
4 Second Board
5 Microprocessor
6 Connector
7 Smoothing Capacitor
8 Fixing Resin
9 Case
9A Slit
9B Slit
10 Filler Resin
11 Fixing Section
11A Protrusion
20 Commercial Power Source
21 Converter
21A Rectifier Diode
21B Rectifier Diode
21C Electrolytic Capacitor
21D Electrolytic Capacitor
22 Inverter
22A IGBT
22B IGBT
22C IGBT
22D IGBT
22E IGBT
22F IGBT
23 Motor
24 Position Detector
25 Inverter Control Circuit
26 Power Supplying Circuit

27 Power Controller
28 Refrigerating System Control Circuit
29 Quick Refrigerating Switch
30 Temperature Input Circuit
31 Load-Driving Circuit
40 Capacitor
40A Container
40B Pin
41 Rubber Isolator
42 Mounting Bracket
43 Power Controller
44 Refrigerating System Control Board
45 Communication Cable
50 Microprocessor
51 IC
52 Chip Resistor
53 Chip Capacitor
54 Electrolytic Capacitor
55 Discrete Component
56 Coil
60 Cluster Socket
61 Temperature Detector
62 Resilient Supporting Member
70 Resin
80 Bracket
81 Control Board
82 Cable
101 Power Converter (Prior Art)
102 Radiator (Prior Art)
103 First Circuit Board (Prior Art)
104 First Spacer (Prior Art)
105 Smoothing Capacitor (Prior Art)
106 Voltage Regulator (Prior Art)
107 Second Circuit Board (Prior Art)

108 Second Spacer (Prior Art)

109 Cover (Prior Art)

Under Patent Cooperation Treaty
35 USC §371(c)(4)

As a below named inventor, I hereby declare that:

my residence, post office address and citizenship are as stated below next to my name; that

I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural names are named below) of the invention entitled: POWER CONTROLLER AND COMPRESSOR OF REFRIGERATING SYSTEM

described and claimed in the international application number PCT/JP00/03740 filed 9 June 2000 and as amended on 10 December 2001 (if any), the specification and claims of which I have reviewed and understand and for which I solicit a patent.

I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a), and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to my international application by me or my legal representatives or assigns, except as follows:

Japanese Patent Appln. No. 11-167919 filed June 15, 1999.

The priority of the above applications (if any), filed within a year prior to my international application is hereby claimed under 35 USC 119. I hereby appoint the following as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the patent office:

Roger W. Parkhurst, Reg. No. 25,177; and/or Charles A. Wendel, Reg. No. 24,453.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO: PARKHURST & WENDEL, L.L.P., 1421 PRINCE STREET, SUITE 210,ALEXANDRIA, VIRGINIA 22314-2805, TELEPHONE (703) 739-0220.

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

3. Full Name of Sole or First Inventor: Koji (Given Name) | (Middle Initial) | HAMAOKA (Family Name)

*4. Inventor's Signature: Koji Hamaoka

Date of Signature: April 8, 2002 (Month / Day / Year)

6. Residence: Osaka-shi (City) | Osaka (State or Province) | Japan JPX (Country)

7. Citizenship: Japanese

8. Post Office address (Insert complete mailing address, including country): 2-5-2-510, Kamiminami, Hirano-ku, Osaka-shi, Osaka 547-0003 Japan

*IF THERE IS MORE THAN ONE INVENTOR USE PAGE 2 AND PLACE AN "X" HERE ☒.

Typewritten Full Name of Second Joint Inventor (if any): Keiji (Given Name) | (Middle Initial) | OGAWA (Family Name)

*4 Inventor's Signature: Keiji Ogawa

5 Date of Signature: April 8, 2002 (Month / Day / Year)

6 Residence: Yamatokoriyama-shi (City) | Nara (State or Province) | Japan (Country) JPX

7 Citizenship: Japanese

8 Post Office Address (Insert complete mailing address, including country): 8-5, Nishi-machi, Yamatokoriyama-shi, Nara 639-1038 Japan

Typewritten Full Name of Third Joint Inventor (if any): Tomonori (Given Name) | (Middle Initial) | NAKANO (Family Name)

*4 Inventor's Signature: Tomonori Nakano

5 Date of Signature: April 8, 2002 (Month / Day / Year)

6 Residence: Higashiosaka-shi (City) | Osaka (State or Province) | Japan (Country) JPX

7 Citizenship: Japanese

8 Post Office Address (Insert complete mailing address, including country): 3-7-13, Takaidanaka, Higashiosaka-shi, Osaka 577-0065 Japan

Typewritten Full Name of Fourth Joint Inventor (if any): (Given Name) | (Middle Initial) | (Family Name)

*4 Inventor's Signature:

5 Date of Signature: (Month / Day / Year)

6 Residence: (City) | (State or Province) | (Country)

7 Citizenship:

8 Post Office Address (Insert complete mailing address, including country):

Typewritten Full Name of Fifth Joint Inventor (if any): (Given Name) | (Middle Initial) | (Family Name)

*4 Inventor's Signature:

5 Date of Signature: (Month / Day / Year)

6 Residence: (City) | (State or Province) | (Country)

7 Citizenship:

8 Post Office Address (Insert complete mailing address, including country):

*Note to Inventors: Please sign name on line 4 exactly as it appears in line 3 and insert the actual date of signing on line 5.

**This form may be executed only when attached to the first page of the Declaration and Power of Attorney form and the specification (including claims) of the application to which it pertains.